FIRST 20 YEARS OF DNDC: MODEL EVOLUTION AND GRAMP

S. GILHESPY [1], S. ANTONY [2], L.M. CARDENAS [1], D.R. CHADWICK [3], A. DEL PRADO [4], C. LI [5], T.H. MISSELBROOK [1], R. REES [6], W. SALAS [7], A. SANZ-COBENA [8], P. SMITH [9], E.L. TILSTON [6], K. TOPP [6], S.H. VETTER [9], J. YELURIPATI [9,10]

[1] Rothamsted Research, North Wyke, Okehampton, UK, [2] ADAS Group Ltd, HQ Pendeford House, Pendeford Business Park, Wolverhampton, UK, [3] School of Environment, Natural Resources and Geography, Environment Centre Wales, Deiniol Road, Bangor University, Bangor, UK, [4] BC3 Basque Centre for Climate Change, Alameda Urquijo 4, 4a 48008, Bilbao Bizkaia, SPAIN, [5] Institute for the Study of Earth, Oceans, and Space, University of New Hampshire, Durham, USA, [6] Scotlands Rural College, West Mains Road, Edinburgh, UK, [7] Applied Geosolutions, LLC, 87 Packers Falls Road, Durham, USA, [8] Departamento de Química y Análisis Agrícola. ETSI Agronomos. UPM, Madrid, SPAIN, [9] Institute of Biological and Environmental Sciences, School of Biological Sciences, University of Aberdeen, 23 St Machar, Aberdeen, UK, [10] The James Hutton Institute, Craigiebuckler, Aberdeen, UK
e-mail: sarah.gilhespy@rothamsted.ac.uk

The DNDC (DeNitrification and DeComposition) model was first developed by Li et al. (1992) as a rain event-driven process-orientated simulation model for nitrous oxide, carbon dioxide and nitrogen gas emissions from the agricultural soils in the U.S. Over the last 20 years, the model has been modified and adapted by various research groups around the world to suit specific purposes and circumstances.

The Global Research Alliance Modelling Platform (GRAMP) is a UK-led initiative for the establishment of a purposeful and credible web-based platform initially aimed at users of the DNDC model. With the aim of improving the predictions of soil C and N cycling in the context of climate change the objectives of GRAMP are to: 1) to document the existing versions of the DNDC model; 2) to create a family tree of the individual DNDC versions; 3) to provide information on model use and development; and 4) to identify strengths, weaknesses and potential improvements for the model.

Materials and Methods

At present limited documentation exists on the differences between successive updates for each of the DNDC model versions. Consequently, users are often unaware of more appropriate versions of the model for their purposes. To rectify this GRAMP has created a database of DNDC model versions and constructed a "family tree". Versions of DNDC were found through a combination of literature searches, web searches and input from the DNDC user-community.

The published literature was reviewed to identify how different modellers applied the DNDC model and the techniques used for model calibration. A range of statistical indicators were also used to compare the performance of different versions of DNDC. Further information on important changes to the model was also obtained as part of a survey distributed to *c.* 1500 model users around the globe. Information gathered included data on validation practices and datasets and records of changes made to individual versions of the model

Results and discussion

Through GRAMP, 17 different versions of the DNDC model have been identified and their history documented. Figure 1 is a schematic diagram of the model versions and how they relate to each other and the early versions of DNDC.

As part of GRAMP over 250 publications involving modelling with the 17 DNDC model versions were identified (Figure 2). In addition to the GRAMP team, the 98 survey respondents identified many strengths and weaknesses of the DNDC model versions which in addition to obstacles to process model uptake and recommendations for addressing the issues arising form the basis of a discussion document.

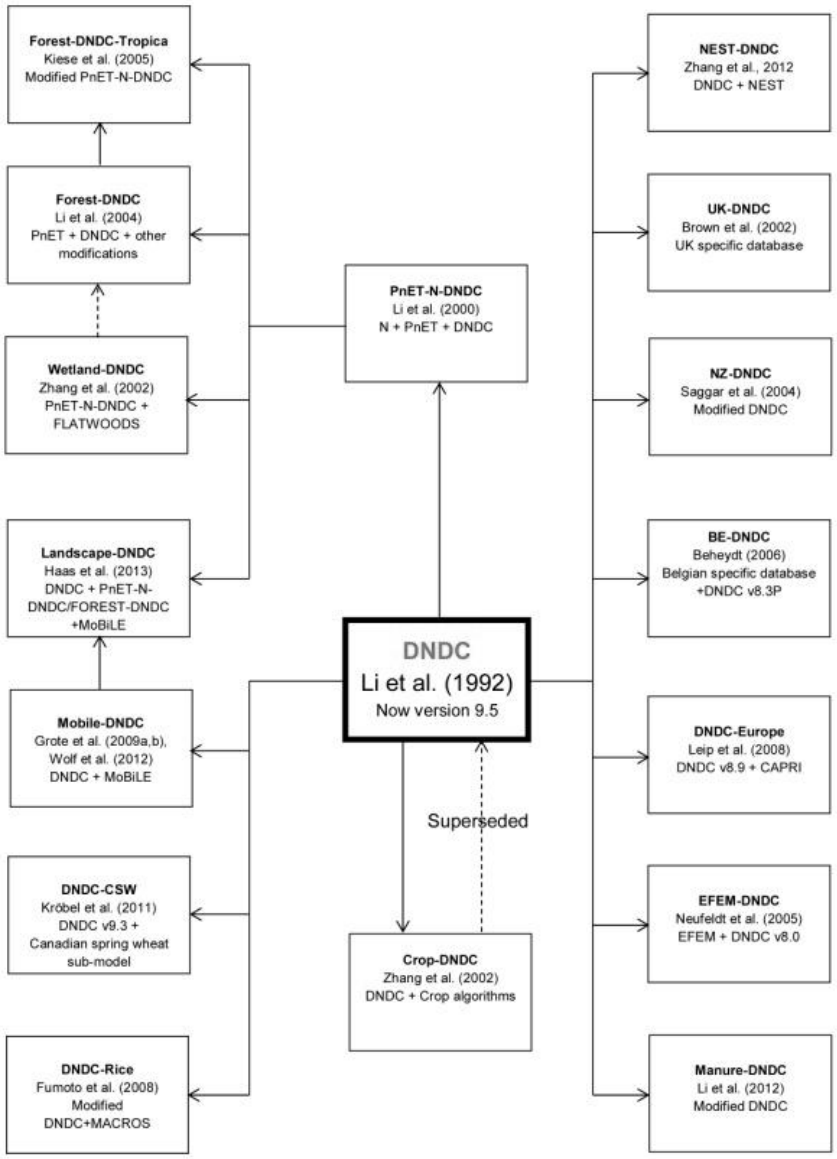
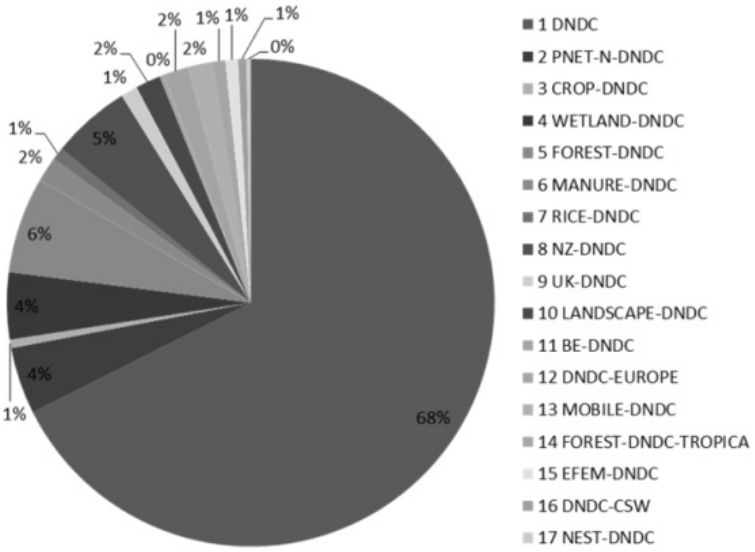


Figure 1. Schematic diagram of the DNDC extended family.



Conclusions

Throughout its 20 year history, the DNDC model has undergone many changes and its on-going value to the scientific community is reflected in the range of versions in current use, the number of current users, and an extensive published literature. However, in common with all biogeochemical process models, the DNDC model has both strengths and weaknesses. The GRAMP project has much to offer to the DNDC user community in terms of promoting the use of DNDC and addressing the deficiencies in the present arrangements for the model's stewardship.

Acknowledgement

The authors would like to thank DEFRA for funding this study.

Li, C. Frolking, S. & Frolking, T.A. 1992. J. of Geophysic. Res., 97, 9759-9776.